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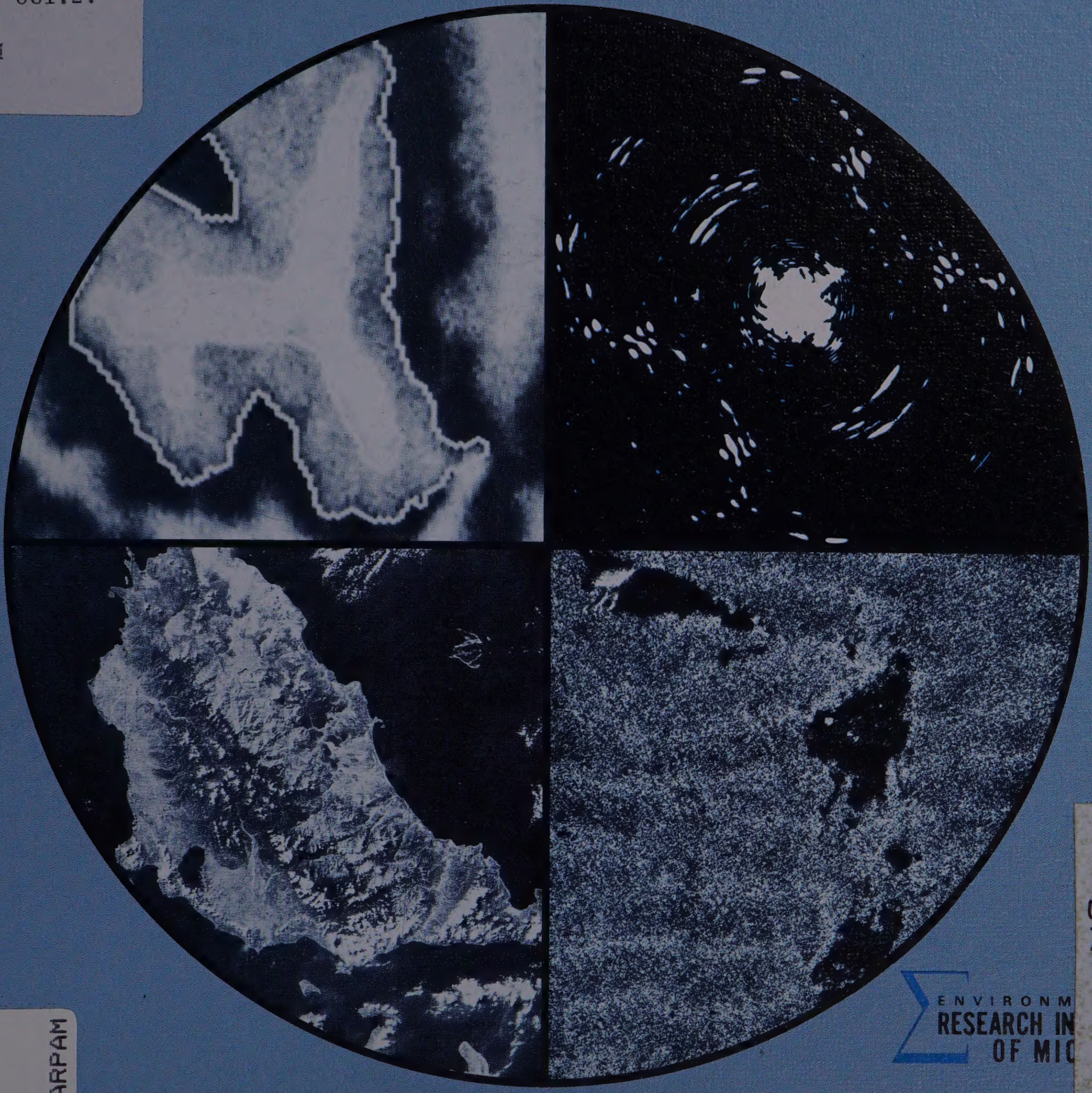

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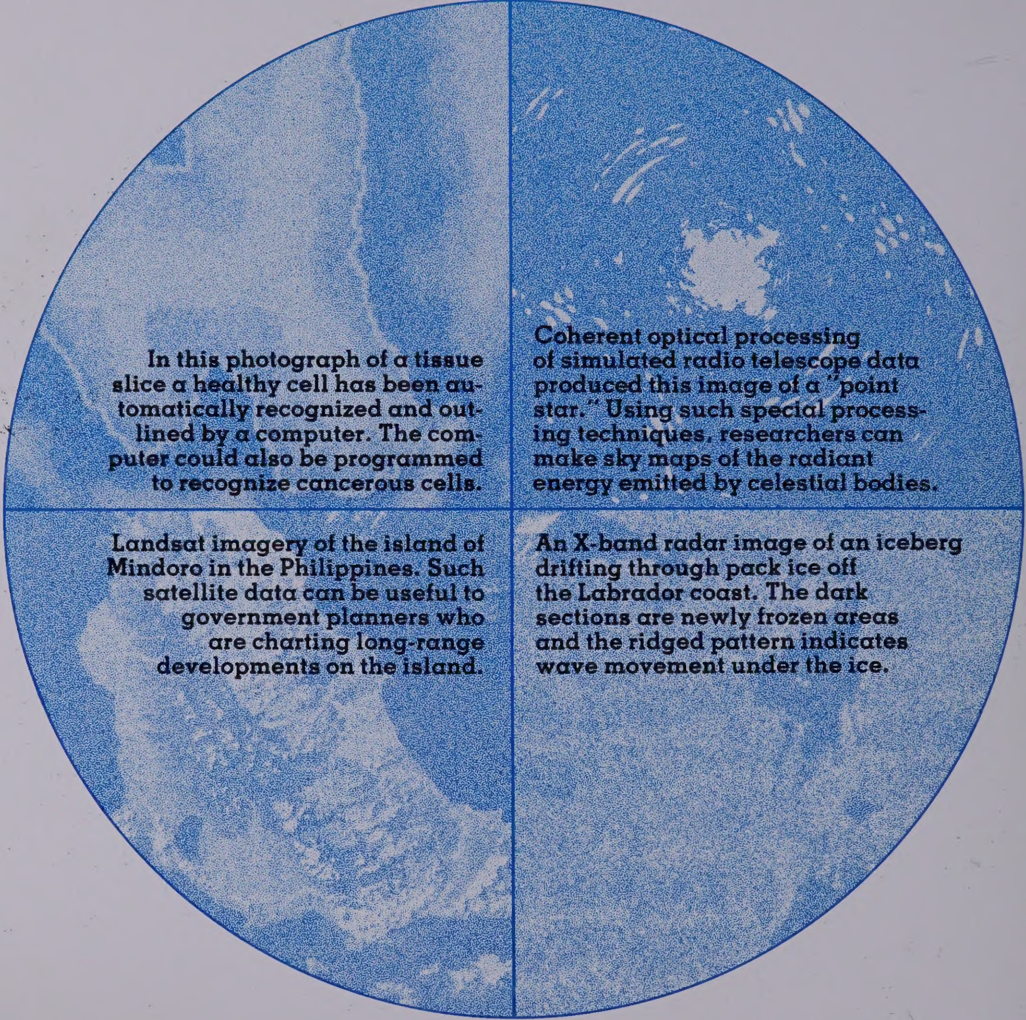

In this photograph of a tissue slice a healthy cell has been automatically recognized and outlined by a computer. The computer could also be programmed to recognize cancerous cells.

Coherent optical processing of simulated radio telescope data produced this image of a "point star." Using such special processing techniques, researchers can make sky maps of the radiant energy emitted by celestial bodies.

Landsat imagery of the island of Mindoro in the Philippines. Such satellite data can be useful to government planners who are charting long-range developments on the island.

An X-band radar image of an iceberg drifting through pack ice off the Labrador coast. The dark sections are newly frozen areas and the ridged pattern indicates wave movement under the ice.

Our front cover represents ERIM's varied activities in advanced scientific and technical research and development over a wide range of human concerns—from the inner workings of the body, through the delicate balances that exist in earth's ecosystem, to the mechanisms at work in outer space.

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN

WILLIAM M. BROWN
President

With my compliments

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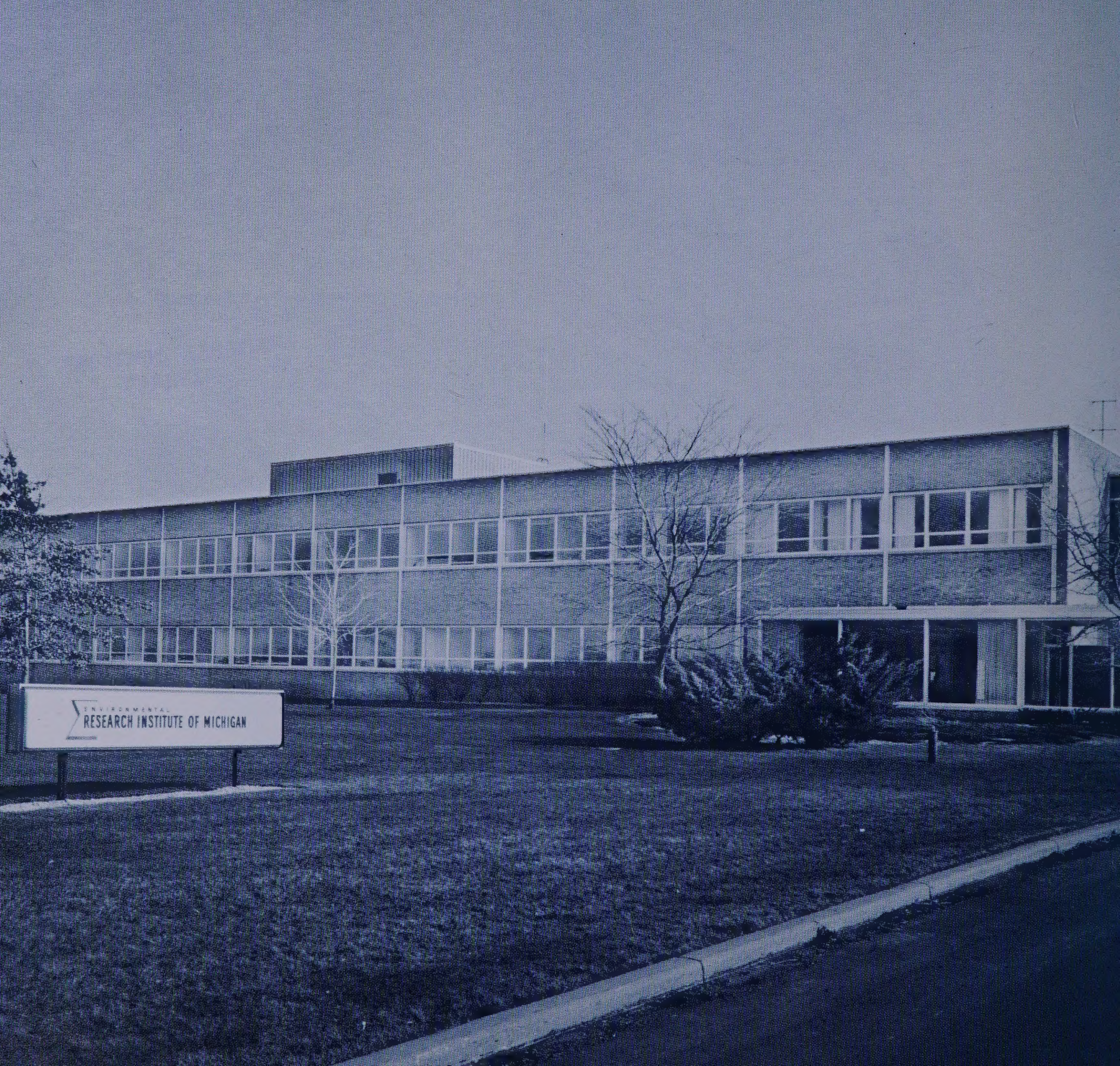
ENVIRONMENTAL
RESEARCH INSTITUTE OF MICHIGAN

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WELCOME TO ERIM

The Environmental Research Institute of Michigan has a unique position in the social structure: it is at once a public institution and a private corporation with the freedom to engage in many, varied research and development activities.

This positioning gives ERIM great leverage in the pursuit of its major objective—to serve as a catalytic agent for the application of advanced science and technology to society's problems. This involves not only solving problems for our customers, but also integrating the interests of many sponsors in order to transfer technology from one area to another and develop programs of service to our State and the Nation.

We welcome and appreciate your continued interest and future support of the Institute.

Wm M Brown

William M. Brown
President

SPONSORING ORGANIZATIONS

- Aero Service Corporation
- AGA Corporation
- Agency for International Development
- Atlantic Research Corporation
- Bendix Corporation
- Calspan Corporation
- Canada (Dominion of)
  - Centre for Remote Sensing
  - Department of Defence
  - Department of Energy
  - Department of Supply and Services
- Chevron USA Incorporated
- Chrysler Corporation
- Clark Equipment Company
- Consumers Power Company
- Daedalus Enterprises
- Defense Advanced Research Projects Agency
- Dow Chemical Company
- Environmental Protection Agency
- ESL Incorporated
- Farrand Optical Company
- Federal Energy Administration
- Federal Highway Administration
- Foster-Miller Associates
- General Electric Company
- Great Lakes Basin Commission
- Honeywell Systems and Research Center
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  - U.S. Geological Survey
- U.S. Department of Justice
- U.S. Navy
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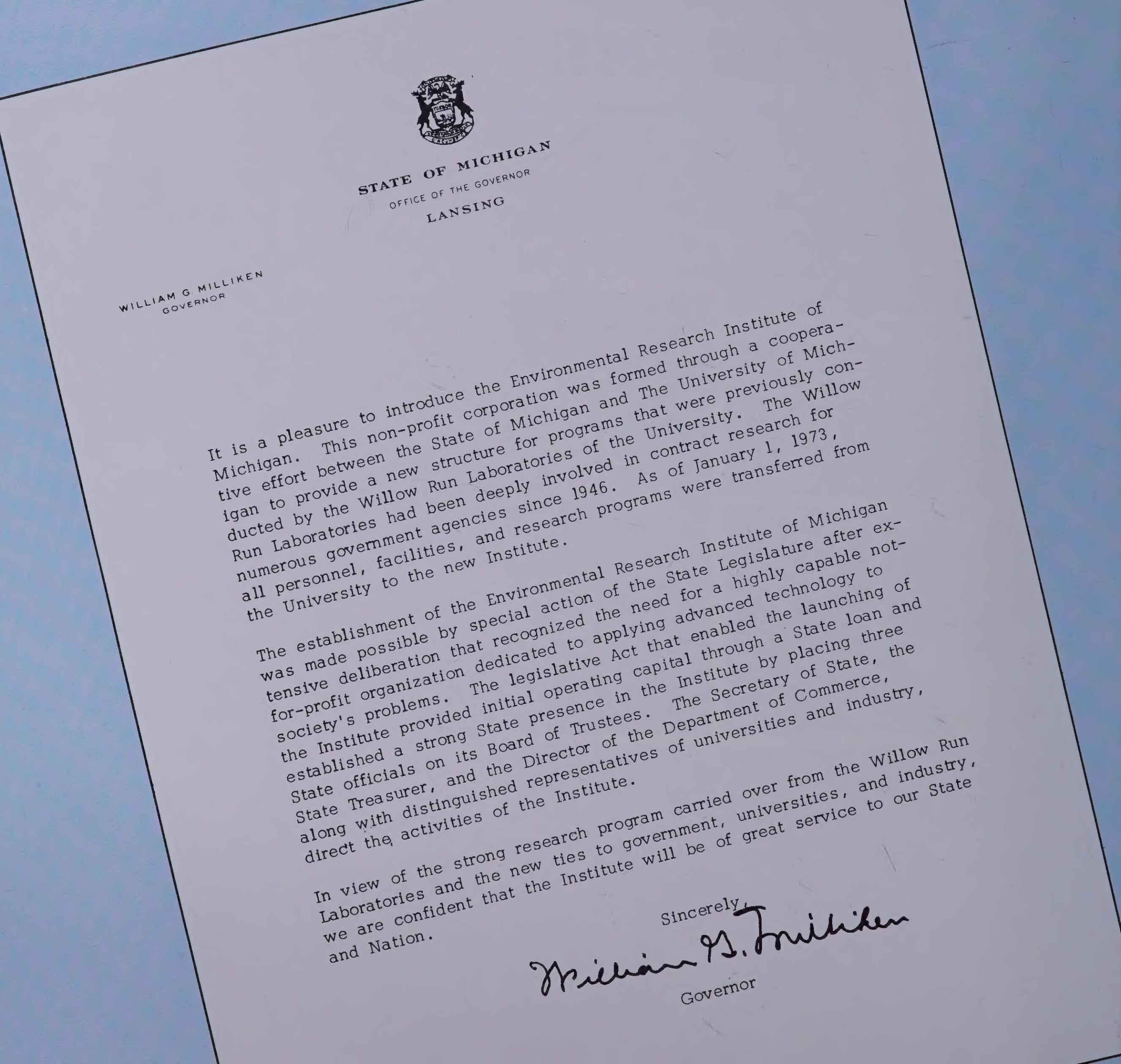
  - Naval Construction Battalion Center
  - Naval Ocean Systems Center
  - Naval Training Equipment Center
  - Naval Weapons Center
  - Office of Naval Research
- University of Michigan
- Ypsilanti School District



STATE OF MICHIGAN
OFFICE OF THE GOVERNOR
LANSING

WILLIAM G. MILLIKEN
GOVERNOR

It is a pleasure to introduce the Environmental Research Institute of Michigan. This non-profit corporation was formed through a cooperative effort between the State of Michigan and The University of Michigan to provide a new structure for programs that were previously conducted by the Willow Run Laboratories of the University. The Willow Run Laboratories had been deeply involved in contract research for numerous government agencies since 1946. As of January 1, 1973, all personnel, facilities, and research programs were transferred from the University to the new Institute.

The establishment of the Environmental Research Institute of Michigan was made possible by special action of the State Legislature after extensive deliberation that recognized the need for a highly capable not-for-profit organization dedicated to applying advanced technology to society's problems. The legislative Act that enabled the launching of the Institute provided initial operating capital through a State loan and established a strong State presence in the Institute by placing three State officials on its Board of Trustees. The Secretary of State, the State Treasurer, and the Director of the Department of Commerce, along with distinguished representatives of universities and industry, direct the activities of the Institute.

In view of the strong research program carried over from the Willow Run Laboratories and the new ties to government, universities, and industry, we are confident that the Institute will be of great service to our State and Nation.

Sincerely,

William G. Milliken

Governor

ERIM—AN OVERVIEW

ORIGINS

The Environmental Research Institute of Michigan (ERIM) was established in 1973 as a not-for-profit corporation by special action of the Michigan State Legislature. This legislative action was the result of a cooperative effort between the State of Michigan and The University of Michigan to provide a new structure for the research programs previously conducted by the University's Willow Run Laboratories.

ERIM thus was established in response to the state's need for a highly capable, non-profit organization dedicated to applying advanced technology to society's problems.

In 1974, ERIM opened its Washington, DC office to facilitate its interaction with various federal agencies. In 1975, partial gifting from the Bendix Corporation made it possible for ERIM to acquire its present building in Ann Arbor.

Since its founding, ERIM has sought to fulfill its purpose of applying advanced research technology to society's needs by strengthening its ties to the nation's universities, government agencies, and industry, and by continuing to expand the capabilities and scope of its research and development programs and applying them to the important real-world problems of its sponsoring client organizations and agencies.

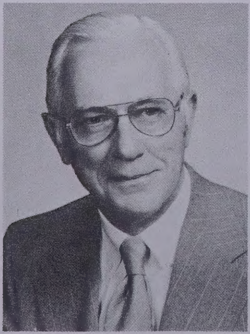
PURPOSE

ERIM's major purpose is to advance scientific theories and methodologies (and associated technologies) to help client sponsors solve important social problems. Typically, these problems are related to defense and military reconnaissance, energy resources, the environment, land use, or urban development.

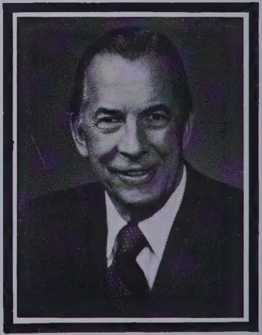
Governor William G. Milliken receiving a photomosaic of the State of Michigan from ERIM's President William M. Brown.

BOARD OF TRUSTEES & OFFICERS

Sitting:
Dr. William M. Brown, Hon. Keith Molin, Dr. George J. Huebner, Dr. William G. Dow, Dr. Adam Kozma
Standing:
Mr. Marvin R. Holter, Dr. Russell D. O'Neal, Mr. John R. Axe, Hon. Richard H. Austin, Mr. Charles W. Mathews, Mr. Robert A. Rosenblum, Mr. Howard W. Courtney, Mr. Richard R. Legault, Hon. Allison Green
Not Shown:
Mr. Gary G. Claypool, Dr. Paul W. McCracken, Mr. Eugene B. Power



On December 16, 1976 Dr. George J. Huebner was elected Chairman of the Board. Dr. Huebner, formerly Director of Research for the Chrysler Corporation, is known as the "father" of the automotive gas turbine engine.



In May, 1977 ERIM suffered the tragic loss of one of its most distinguished Trustees, Dr. Edward N. Cole. His contributions and advice to the Institute will be sorely missed.

STAFF

ERIM employs some 285 full-time staff members from 23 states and 2 foreign countries. There are also about 60 part-time employees, including students in various education-exchange programs, and faculty members from neighboring universities who choose to participate in ERIM programs as part of their overall professional activities.

ERIM's staff represents a combination of extensive formal education and on-the-job experience, with more than a quarter of the research staff holding doctorates, just under half with master's degrees, and over a quarter having their bachelor's degrees.

The staff also represents a wide variety of disciplines and fields of expertise.

Sciences

- Forestry
- Geology
- Geography
- Mathematics
- Natural Resources
- Physics

Engineering

- Aerospace
- Chemical
- Computer Sciences
- Electrical
- Industrial
- Mechanical

Others

- Accounting
- Business Administration
- Communications
- Education
- Graphic Arts
- Photographic Arts
- Legal

PROFESSIONAL AWARDS & ACTIVITIES

ERIM has received the 1976 William T. Pecora Award from the National Aeronautics and Space Administration and the U.S. Department of the Interior "In recognition of individual and collective continuing contributions to the understanding of terrestrial phenomena through remote sensing techniques."

Emmett N. Leith and Juris Upatnieks continued to receive awards honoring their pioneering contributions to practical holography, including the 1976 Holley Medal from the American Society of Mechanical Engineers; the 1975 Inventor of the Year Award from the Association for the Advancement of Invention and Innovation; and the 1976 R.W. Wood Prize from the Optical Society of America.

In addition to their work at ERIM, some staff members have been appointed to a variety of committees, ranging from the Executive Committee of the Air Force Scientific Advisory Board and the US-USSR Joint Coordination Committee to the Committee on Remote Sensing Programs for Earth Resources Surveys.

Members of ERIM's staff held high editorial positions on several journals including the IEEE "Aerospace and Electronic Systems Society Journal" and "Remote Sensing of Environment," while more than 50 articles by ERIM authors appeared during 1976 and 1977. Other activities included teaching (at both The University of Michigan and Washtenaw Community College) and guest lectures to many professional societies, schools, and civic groups.

REMOTE SENSING SYSTEMS

Historically, ERIM has played a major role in the development of both the multispectral scanner and fine-resolution, synthetic-aperture radar—two milestones in remote sensing technology.

Today, ERIM continues to design and build new systems, in addition to using the combined expertise of its staff to advise other systems designers.

A DHC4A Caribou and a CV580 Convair are the two most recent additions to ERIM's fleet of aircraft, used to collect data in support of the Institute's multi-sensor research programs. They are an integral part of the ERIM flight facility at Willow Run Airport; the facility is equipped to provide everything necessary to operate, maintain, and modify the aircraft, as well as all associated research instrumentation used in the development, testing, and operation of airborne sensor equipment.

ACTIVE/PASSIVE SCANNING

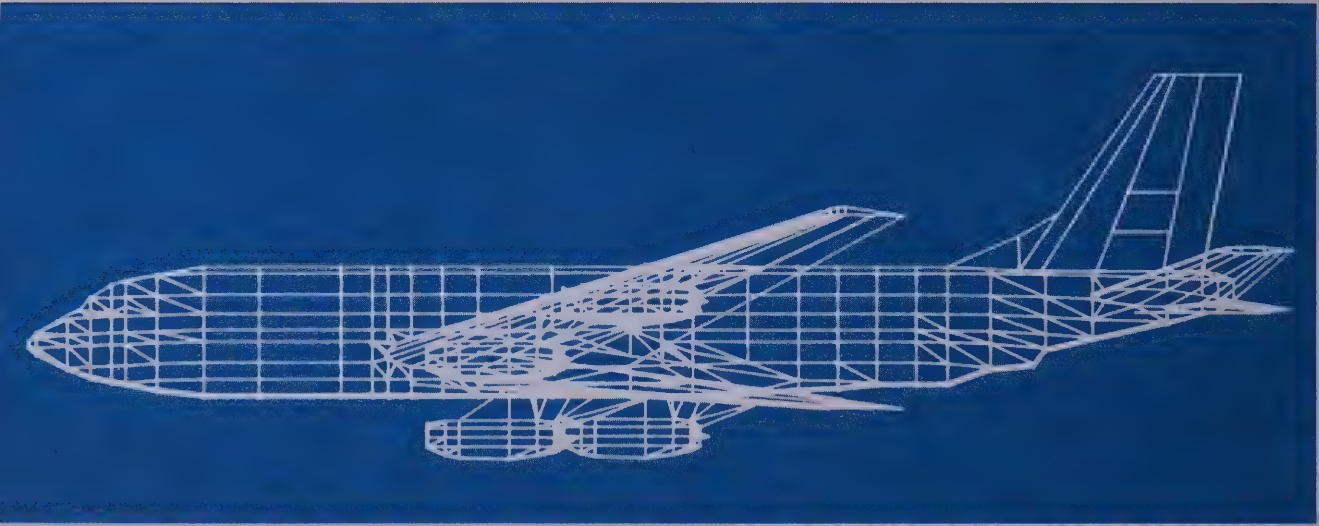
A major breakthrough in remote sensing technology occurred at ERIM when a three-dimensional imaging system was constructed and successfully flight-tested. This is an active system using laser imaging technology. It is expected to have far-reaching effects on the design and application of future sensors, and will be of major importance in the area of military reconnaissance.

A system incorporating both active (laser) and passive (multispectral) scanning was constructed and recently tested at ERIM. This new system was designed to fulfill NASA requirements for a scanner that will map terrain, identify geologic features, and measure vegetation heights, water depths, and other features.

MODELING

Modeling is of considerable value in understanding, simulating, and evaluating the performance of natural and man-made systems. In many cases the models are very general and represent a considerable investment.

Modeling activities at ERIM cover a wide range, from the electro-magnetic radiation emitted or reflected by typical scenes of targets (objects which one desires to observe) and their backgrounds to vegetation canopies, wildlife habitats, or the transmission and scattering of light in water.



A geometrical approximation for the Boeing 707 aircraft, used for the ERIM multifaceted model.

RADAR SYSTEMS

ERIM is at the forefront of research and development in the field of synthetic-aperture radar (SAR). We have developed one of the finest-resolution, airborne, SAR systems presently in existence (the Spotlight radar) and the first multi-frequency, multi-polarization SAR (the X-L Band Imaging Radar).

ERIM's Spotlight radar is a very-fine-resolution, X-band system with a mode of operation which differs significantly from conventional SAR strip mapping. The Spotlight radar is installed in ERIM's C131B aircraft.

An extension of the spotlight concept, the multi-mode radar, is also being developed. This radar will be, essentially, a conversion of the single-scene Spotlight radar to a multi-scene, computer-controlled system. With this system selection of the ground areas to be mapped is quite flexible. During a single pass the system can provide various combinations and arrangements of both spotlight and strip-map scans.

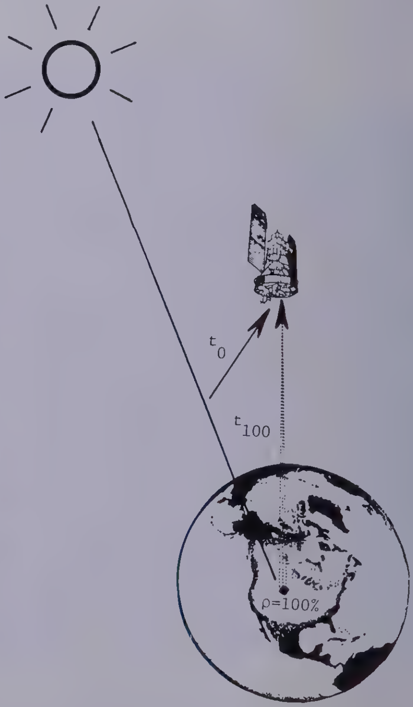
ERIM's airborne X-L Band Imaging Radar was developed to provide imagery from which considerably more information could be extracted than from single-frequency, single-polarization data. This system is carried in ERIM's C46 aircraft and has been used extensively for research in a variety of remote sensing applications.

THEMATIC MAPPER

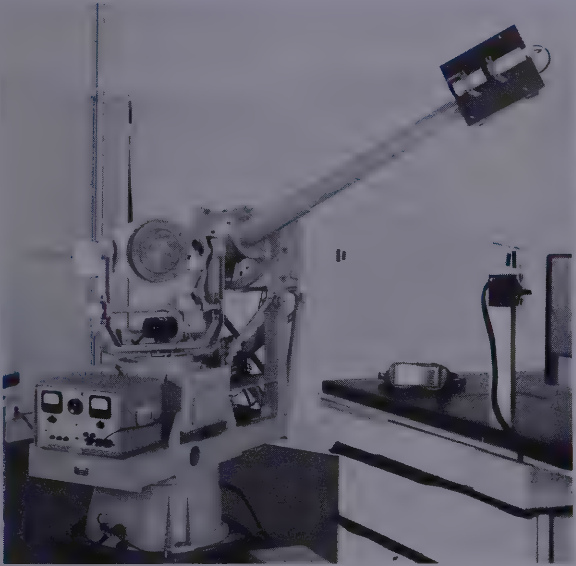
ERIM, with 25 years of experience in the design of multispectral scanning systems, and with a long and continuing history of work with agricultural applications of the technology, has conducted studies on the selection of a seventh spectral band for NASA's thematic mapper—a second-generation multispectral scanner that will be used in future Landsat satellites.

Using data from several outside sources, ERIM scientists modelled the improvement in classification accuracy of various types of rocks under a wide variety of observation conditions, and made specific recommendations concerning the proposed new capability for Landsat-D.

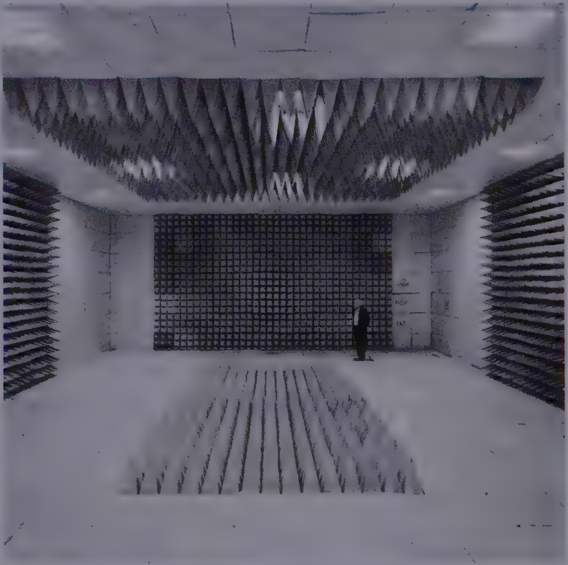
ERIM's rotary platform is a ground based, range-Doppler radar imaging system instrumented to image objects at microwave frequencies. The facility employs a platform to rotate target scenes and generates imagery with exceptionally fine resolution. With this system, targets can be imaged, radar parameters can be varied in a controlled manner, and changes in the imagery can be observed—all at less expense than with an airborne radar.



Geometry of the ERIM radiative transfer model used to support the selection of a seventh spectral band for the Landsat-D thematic mapper.



The ERIM-designed gonioreflectometer is used to measure the bidirectional reflectance of materials: the desired angles of the illuminating and reflected beams are programmed and the instrument automatically scans and measures the reflectance at the desired transmitted/reflected angles pairs. It is one of many instruments in ERIM's extensive laboratory facilities for the measurement of optical properties of materials and gases.



The microwave anechoic chamber is 50 feet long, 30 feet wide, and 15 feet high; the ceiling, floor, and walls are covered with two kinds of microwave absorbing material. The room can be used (1) to measure the radar cross sections of various objects as a function of aspect angle, (2) to test special radar transmitters and receivers, and (3) to make antenna measurements.

RAMTEK

Introducing the ERIM APPLICATIONS DIVISION

[illegible] Research Institute [illegible] ed [illegible] Bendix Corporation [illegible] ERIM, through a gift-sale agreement with the Bendix Aerospace Systems Division.

[illegible] rated into the ERIM Applications Division [illegible] capabilities for the processing, anal- [illegible] —with detailed geometric registration for areas as small as a portion of a city, or as large as an entire country.

Introducing the ERIM APPLICATIONS DIVISION

The Environmental Research Institute of Michigan has acquired the data processing facilities of the Bendix Corporation's Earth Resources Data Center. This facility, along with key ERDC personnel, was recently transferred to ERIM through a gift-sale agreement with the Bendix Aerospace Systems Division.

These resources have been incorporated into the ERIM Applications Division, which now offers unmatched capabilities for the processing, analysis, and display of remote sensing data—with detailed geometric registration for areas as small as a portion of a city, or as large as an entire country.

Progress from Cross-Fertilization

If society is to effectively manage and control the earth's diminishing resources fairly and equitably, planners the world over must have access to large amounts of information. It has long been recognized that remote sensing is the only way to obtain this information in a timely fashion.

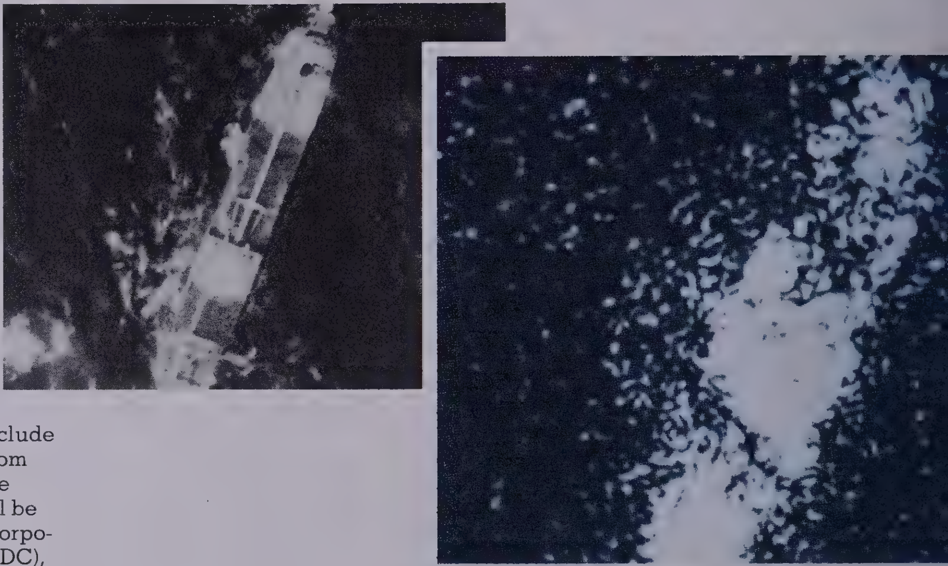
There are many remote sensing tools available today—aerial cameras, multispectral scanners (both airborne and spaceborne), and radar systems—and each tool has its own unique advantages and disadvantages for specific applications. But too often development of each type of sensor has been conducted in isolation from the others; as a result the benefits of modern sensor systems have not been fully realized in the past.

Now ERIM, who pioneered the development of both the multispectral scanner and synthetic aperture sidelooking radar, has formed an Applications Division to conduct and coordinate research in all sensor application areas.

This new Applications Division will include some existing programs and expertise from infrared and radar remote sensing. These already impressive R&D capabilities will be enhanced by the transfer of the Bendix Corporation's Earth Resources Data Center (ERDC), with data processing facilities which will add a new dimension to the work being done at ERIM.

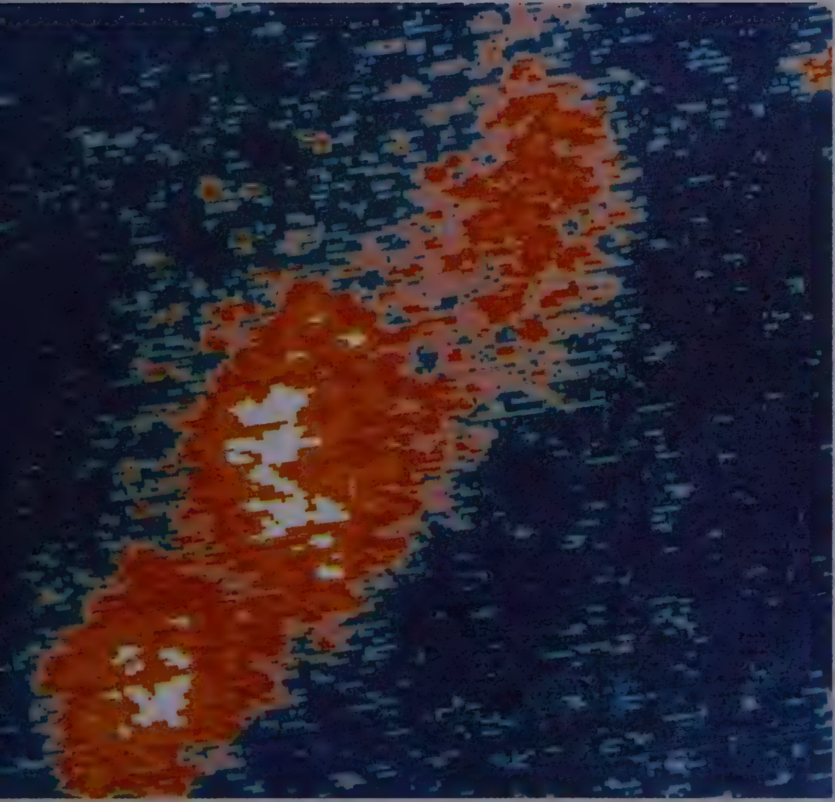
Now ERIM is able to combine its existing superiority in high-quality data classification with ERDC's excellent capabilities for large-area data processing that has a high degree of geometric fidelity—and to produce color photographic products up to 30 in. by 40 in. in size.

In addition to the ERDC data processing facilities, the new Applications Division will either contain or have access to ERIM's array of data gathering and processing equipment, including:



An example is this optically processed radar signal film of a ship (see aerial photograph) which has been digitized. A false-color composite image was then produced on an inkjet printer in a manner reminiscent of multispectral data processing. The image was produced by LIGMALS, a system developed by an ERIM scientist, and highlights several interesting features that were not apparent on the original radar imagery.

in Research

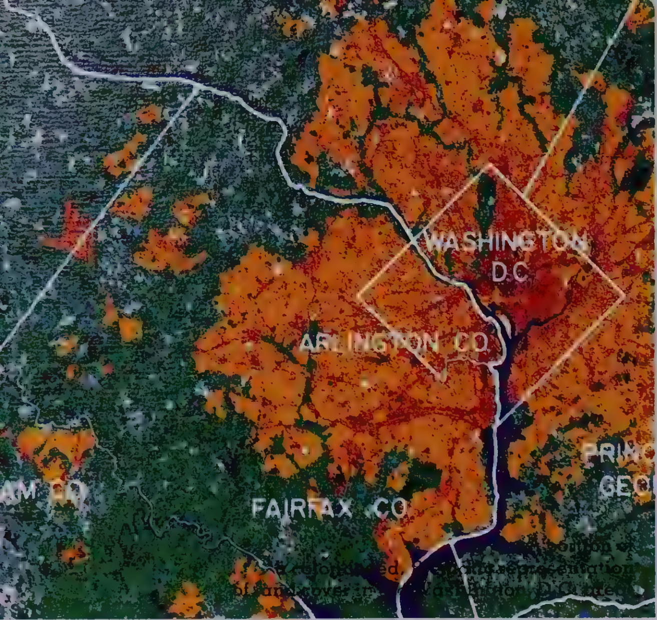


- a mobile laboratory specially equipped to generate, record, and measure acoustic and seismic signatures at any location
- multispectral scanners in several configurations suited to a variety of purposes
- ERIM's X-L Imaging Radar, the finest-resolution multi-frequency synthetic aperture radar available today
- the Multivariate Interactive Digital Analysis System (MIDAS), ERIM's special, high-speed computer system, designed and built to digitally process, analyze, and display multispectral scanner data
- the Precision Optical Processor (POP), a coherent optical system that processes synthetic aperture radar data, records on photographic film, and generates fine-resolution radar imagery
- the Advanced Radar Imaging and Exploitation System (ARIES), a computer system designed for simultaneous program development, data processing, image exploitation, and digital imagery storage.

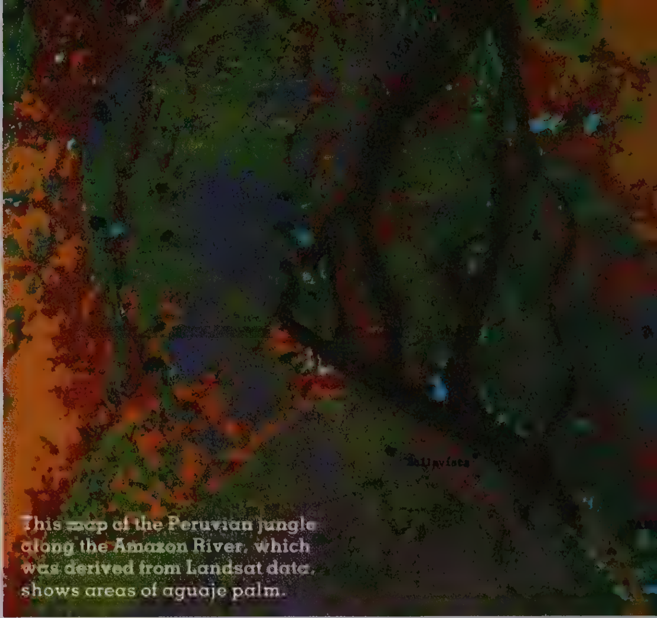
These exciting new developments will benefit sponsors of projects at ERIM in many ways. The integration of sensor applications work into one division will dramatically increase the opportunities for cross-fertilization between areas of remote sensing technology and generally enhance the benefits derived from current and future advances in sensor systems. Acquisition of the Bendix facilities will not only increase the range of material produced in the course of research projects, but will also help ERIM make even greater strides in information extraction—the technology that is most vital to resource managers and environmentalists.

In a larger sense, too, an activity of great value to society is being continued so that the full potential of remote sensing can be realized.

Mr. Donald S. Lowe, who has been appointed Director of the new Division, will be glad to answer questions about the meaning of ERIM's reorganization and expanded facilities, and the opportunities they present.

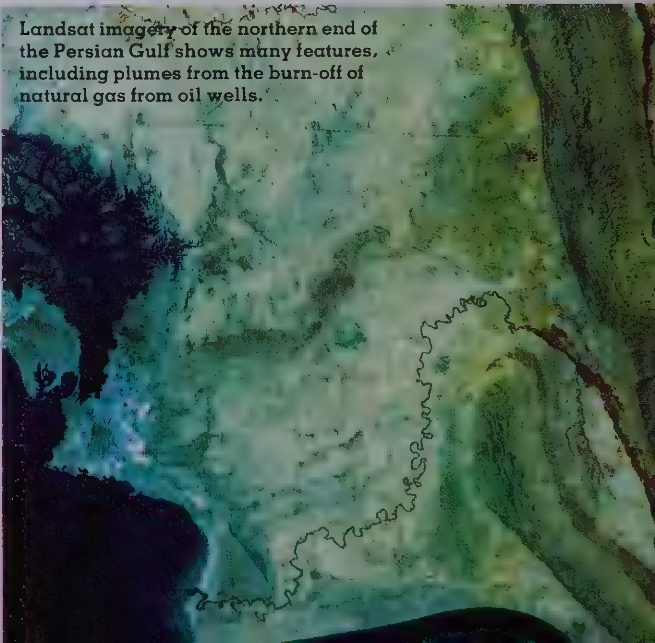


[illegible] portion of [illegible] colorcoded, [illegible] representation of land cover in [illegible] Washington, D.C. area.



This map of the Peruvian jungle along the Amazon River, which was derived from Landsat data, shows areas of aguaje palm.

The highlighted area [illegible] of a gas field in West Virginia [illegible] represent linear [illegible] surface features [illegible] which may indicate [illegible]



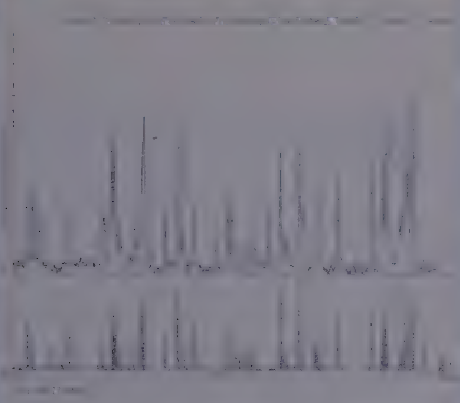
Landsat imagery of the northern end of the Persian Gulf shows many features, including plumes from the burn-off of natural gas from oil wells.

DATA COLLECTION, PROCESSING, & ANALYSIS

[illegible]

[illegible] storage and retrieval.

The gridded projection of a portion of the I-94 expressway near Ypsilanti, Michigan (small box) shows one way in [illegible] imagery — the bright spot in the box is a large sign over the median. ARIES (the Advanced Radar Imaging and Exploitation System) is equipped with a special-purpose processor, associated systems, and computers for simultaneous pro- [illegible] image exploitation, and digital imagery [illegible]



This computer plot of the water vapor absorption spectrum at 1000 K, taken with the high-resolution [illegible] the pieces of sophisticated equipment in the molecular spectroscopy lab, which is used to make absorption, emission, and kinetic measurements of [illegible] structure, atmospheric transmission, hot-gas radiant intensities, molecular energy transfer, and gas-detection systems.

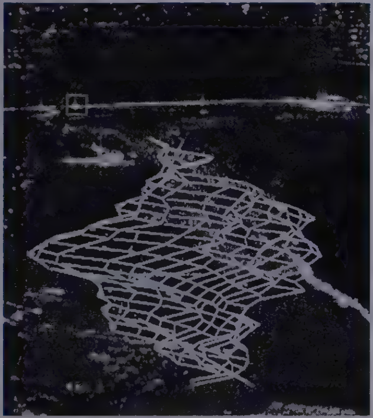
An ERIM researcher at work in one of the extensive electro-optics laboratories [illegible] holographic optical elements, display [illegible]

[illegible] magery of the northern end of the Persian Gulf shows many features, [illegible] gas from oil

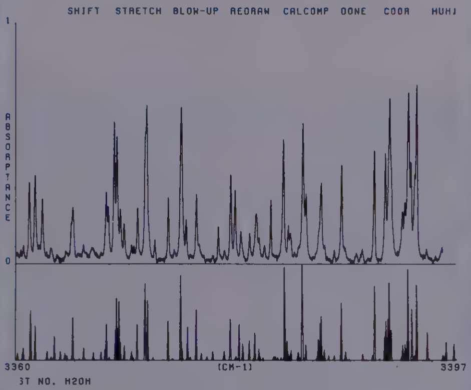
DATA COLLECTION, PROCESSING, & ANALYSIS

Developing sophisticated sensors and collecting large amounts of data are of value only if the data can be quickly recorded and processed, and useful information efficiently extracted.

Much research at ERIM, therefore, is concerned with developing sophisticated equipment and techniques for rapid, high-capability data recording, processing, storage, and retrieval.



The gridded projection of a portion of the I-94 expressway near Ypsilanti, Michigan (small box) shows one way in which ARIES can enhance radar imagery—the bright spot in the box is a large sign over the median. ARIES (the Advanced Radar Imaging and Exploitation System) is equipped with a special-purpose processor, associated systems, and computers for simultaneous program development, data processing, image exploitation, and digital imagery storage.



This computer plot of the water vapor absorption spectrum at 1000 K, taken with the high-resolution spectrometer, compares actual test results with theoretical calculations. The spectrometer is one of the pieces of sophisticated equipment in the molecular spectroscopy lab, which is used to make absorption, emission, and kinetic measurements of gases at ambient and elevated temperatures. These measurements are used in studies of molecular structure, atmospheric transmission, hot-gas radiant intensities, molecular energy transfer, and gas-detection systems.

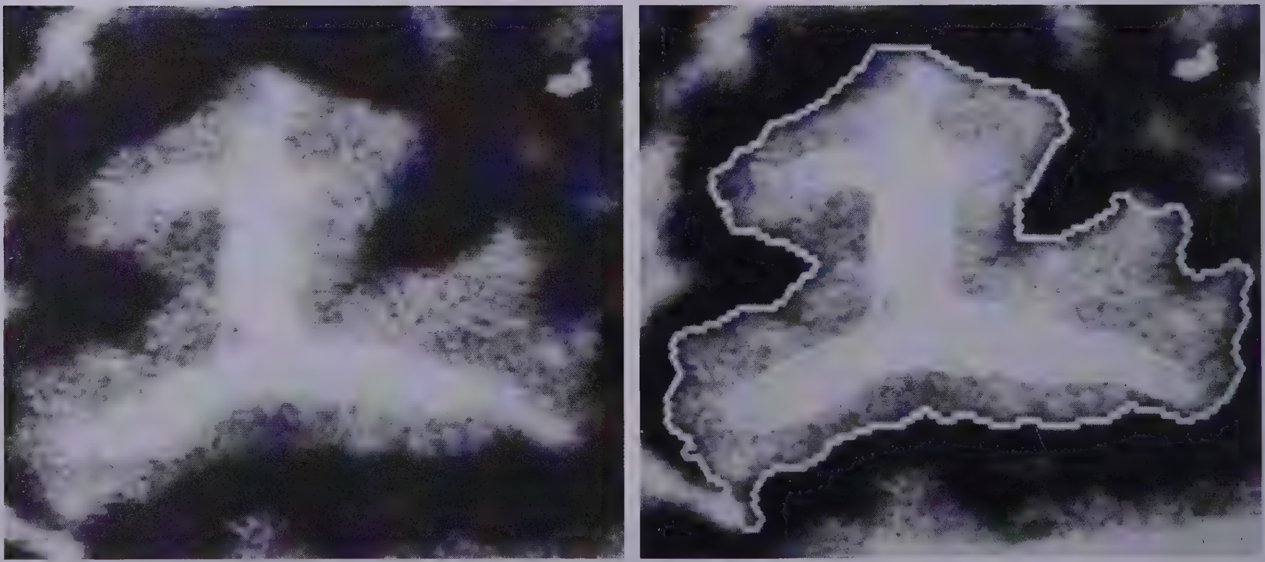
An ERIM researcher at work in one of the extensive electro-optics laboratories equipped to perform specialized research into coherent optics. The labs include holographic optical elements, display holography, electro-optic devices, and optical recording materials.

AUTOMATIC, REAL-TIME PATTERN RECOGNITION

Work on the modulated laser scanner led to the development of a "cytocomputer" for processing three-dimensional data for automatic object cueing. The system is oriented toward image processing, and employs highly parallel data processing structures.

The computer can be programmed to automatically recognize, analyze, and/or classify patterns based on data input images, and produce new imagery in real time which identifies objects in the original or presents selected information on their characteristics.

The concepts and procedures being examined at ERIM will have many applications—to conventional photographic images, to images produced by scanners which record special properties such as height or temperature, or even to microphotographs of human cells for medical research.



Given a photograph of a tissue slice (left), the cytocomputer has automatically recognized and outlined a healthy cell (right). The computer could also be programmed to recognize cancerous cells.

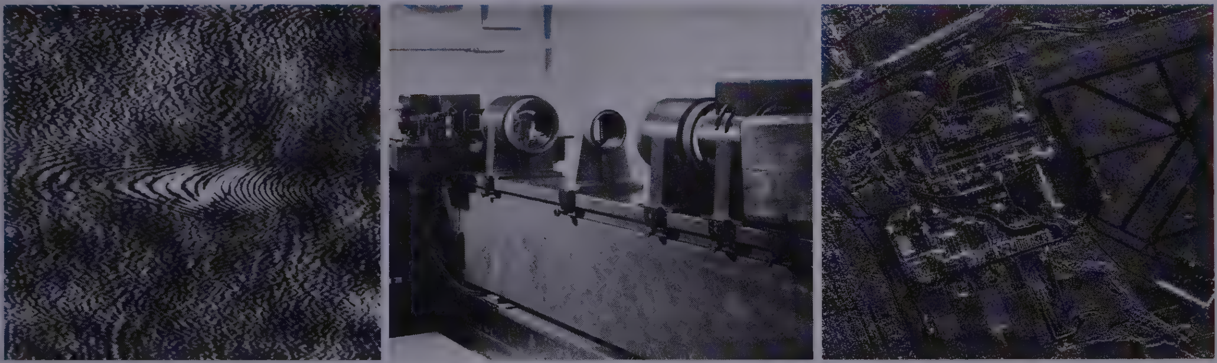
HOLOGRAPHY

ERIM's continuing involvement in the field of holography ("3-D" or "lensless" photography) was highlighted when the Institute donated the laser used to make the first holograms to the Smithsonian Institution.

Much recent holographic research has concentrated on the continuing development of holographic optical elements which, in addition to their low cost and light weight, have unique advantages for some optical systems.

Current research includes the design of a heads-up display system for the Air Force, using large holographic lenses on dichromated gelatin. Another project involves designing an advanced optical processor that uses holographic rather than conventional optics.

ERIM scientists are also studying the use of holographic scanning devices in the development of automated "point-of-sale" systems for supermarkets.

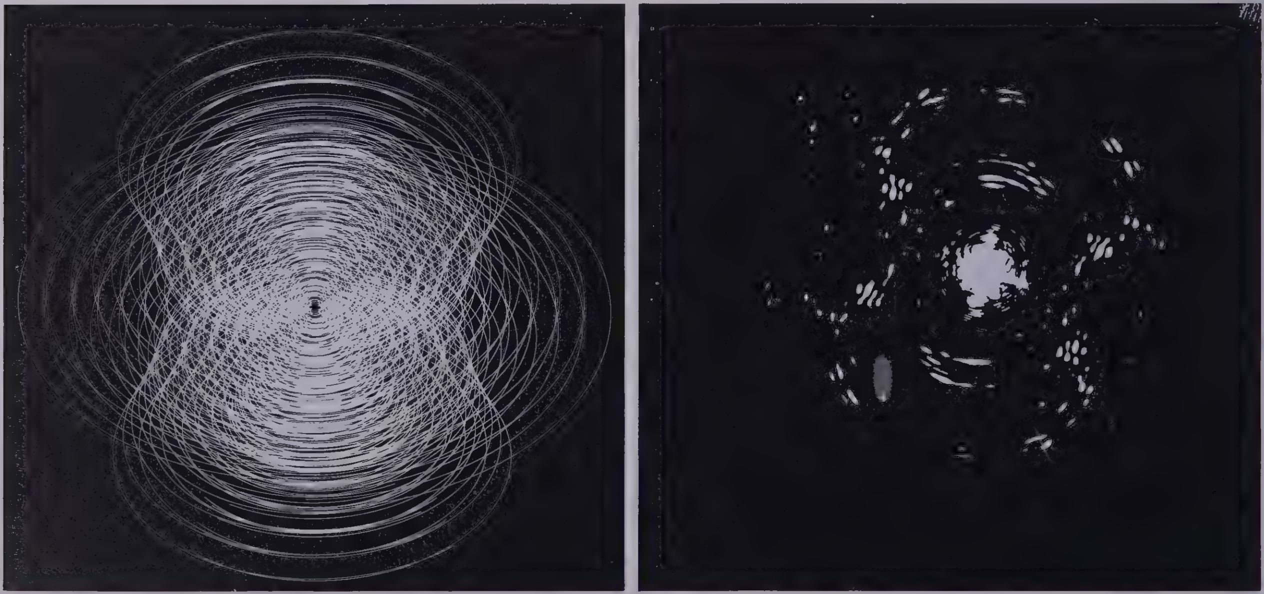


Raw data film is transformed into meaningful images in the Precision Optical Processor (POP), a coherent optical system that processes synthetic-aperture radar data recorded on photographic film and generates fine-resolution radar imagery. Other systems include the Image Processing facility and the Data Modifying and Recording facility. The former was designed and built to digitize the wide dynamic range of image intensities, which is several orders of magnitude greater than the range which can be accurately recorded on photographic film. The latter facility is used for many data handling, modifying, and processing experiments. It includes a data perturber/offset-converter unit and a fine-resolution CRT-film recorder.

RADIO TELESCOPE

Experts at ERIM are studying the theoretical and experimental use of coherent optics to process data provided by the Very-Large-Antenna now being developed at the National Radio Astronomy Observatory in Charlottesville, Virginia.

Although coherent optical processing has been in use for about ten years, it has never been applied to this type of data before. Researchers at ERIM have therefore developed several special features for their equipment that are not used in conventional processing.



Simulated radio telescope data (left) was optically processed to produce an image of a point "star" (right).

REAL-TIME RECORDING & PROCESSING

To shorten the time between the recording of data and the viewing of the data by the operator, ERIM engineers have developed an optical device that can record data and produce a readout in a matter of seconds, while also maintaining a high standard of optical quality and data fidelity.

A study looked at electron-beam writing on thermoplastic film and light-beam writing on photoplastic film, and included research on materials as well as on the design of the overall system.

Development efforts have led to advances in real-time data processing. This concept, which is being implemented and tested under several different contracts, will apply to all areas of remote sensing where a lot of data must be processed rapidly for quick pattern recognition, image enhancement, and signal processing. It could prove to be vital in the operation of defense surveillance systems, and also offers the very interesting potential for a computer-controlled holographic display device.

The developments in remote sensing systems and the collection and processing of sensor data are all directed at obtaining information which can be applied toward the solution of various socially significant problems.

The electron beam/thermoplastic recorder.

ENVIRONMENTAL APPLICATIONS

The developments in remote sensing systems and the collection and processing of sensor data are all directed at obtaining information which can be applied toward the solution of various socially significant problems.

BATHYMETRY

An experiment to test the usefulness of high-gain Landsat data in updating navigation charts was designed here and carried out with ERIM's direction by Jacques Cousteau and his research team, in conjunction with scientists from NASA's Goddard Space Flight Center and Johns Hopkins University.

The data were found accurate to within 10% at depths to 22 meters—the range most important in shipping.

DATA BASES

Applications of remote sensing technologies can give regional and local planners valuable information to use in making day-to-day decisions in problem areas such as zoning, highway planning, and the construction of sewage systems.

An ERIM project for the Toledo Metropolitan Area Council of Governments has pioneered the data base concept—gathering data from many sources (aerial photographs, maps, field surveys) and storing it in a computer so that it can be examined and analyzed quickly. A new, rapid method for translating information from aerial photographs directly into a computer format was developed during the program.

ENERGY CONSERVATION

ERIM has assembled a multidisciplinary group of scientists to examine different ways to discover and correct energy losses.

A flight over Ypsilanti, Michigan, sponsored by the Federal Energy Administration, produced thermal-infrared imagery of the city's rooftops which enabled city planners to pinpoint homes that were losing too much heat.

A similar flight was conducted over Jackson, Michigan at the request of Consumers Power Company. The resulting color-coded temperature map dramatically demonstrates to homeowners the inadequacy of their existing insulation.

ERIM's mobile laboratory is available to generate, record, and measure acoustic and seismic signatures at any location, for a multitude of investigative purposes. The lab includes, among other sophisticated equipment, specially designed, all-terrain-scan acoustic sensors, a unique shear wave generator, and a special-purpose computer.

The AGA Thermovision is a portable instrument for producing a live thermal image display; its uses range from identifying sources of heat loss in buildings to detecting medical abnormalities in the human body. It has been especially adapted by ERIM to measure temperatures from −20 to 900° C; in addition, it has a virtually flicker-free display screen and a camera attachment to provide permanent documentation.

FOREST AND WILDLIFE MANAGEMENT

Forest and wildlife managers often find it difficult to obtain accurate information quickly, especially if they are responsible for a very large area.

Studies of the effect of spatial resolution on the accurate classification of forest features from multispectral scanner data are expected to be important for the future use of scanners in forest mapping. ERIM is also creating formats and designing procedures for storing ancillary information about forests (their topography, soils, climates, etc.) in a way that will improve classification and be easily accessible to forest managers.

ERIM's continuing program of waterfowl habitat monitoring, conducted over North Dakota wetland areas, has shown that Landsat data can be used to estimate pond numbers and provide an indication of duck production. A modeling technique developed here for mapping the amount and quality of various wildlife habitats may prove to be another valuable management tool.

GEOPHYSICS AND SEISMICS

A project in Colorado for the Bureau of Mines studied ways in which different sensing concepts (seismics, earth resistivity, and audiomagnetotellurgics) can be used to aid oil shale mining operations. The project also led to the construction of a digital geophysical model which simulates seismics, gravity, and resistivity data. The model is expected to be useful in any type of mineral exploration.

When ERIM's unique S-wave generator was used in an underground coal gasification project in Laramie, Wyoming, researchers were able to locate an underground water-filled cavity using seismic data.

ERIM scientists have even been to Antarctica to measure the behavior of shear waves as they travel through the Ross Ice Shelf. This study was conducted in conjunction with scientists from Michigan State University and was sponsored by the National Science Foundation.

Nearer home, ERIM is assisting the Dow Chemical Company in its experimental efforts to find practical methods of extracting energy from the extensive oil shale deposits that underlie Michigan and many other states. ERIM has two roles in the project, which is funded by the Department of Energy: to monitor and assess the environmental impact of Dow's activities, and to determine the extent of the fracturing of the oil shale deposit before the underground retorting is begun.

OCEAN RESEARCH

Four-channel, synthetic aperture radar data collected by ERIM's X-L Imaging Radar off the Florida and New England coasts is being used to determine what information about oceans can be obtained from SAR data.

Results from the Marineland Experiment in Florida are helping give scientists a better insight into how ocean waves are imaged with a SAR system. The processing of data from the experimental flight in New England demonstrated that the radar could identify fishing vessels in coastal waters.

The knowledge gained from these projects should also prove useful in the design of SEASAT, NASA's satellite intended for monitoring the world's oceans.

SEA ICE AND ICEBERGS

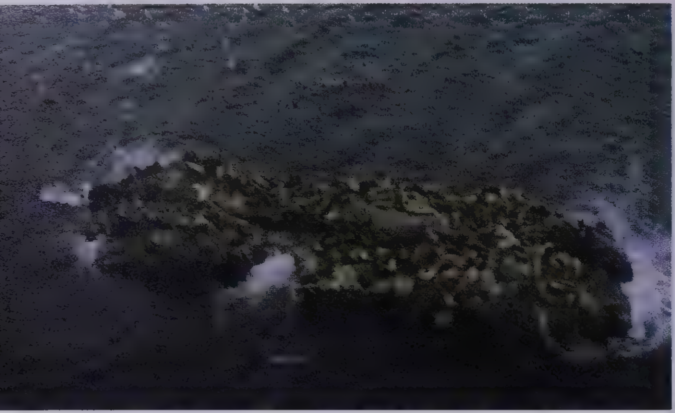
Early in 1977 the ERIM X-L band radar was flown in our C46 aircraft from Michigan to Newfoundland and back, to obtain four-channel imagery of areas of Newfoundland and the Labrador coast. The purpose of the program, which was sponsored by the Centre for Cold Ocean Resources (C-CORE) of the University of Newfoundland, was to investigate the system's capability to characterize sea ice and icebergs. Preliminary analysis indicates that synthetic aperture radar can indeed detect icebergs and identify ice types.

SHORELINE ECOLOGY

ERIM prepared an atlas of Michigan's extensive Great Lakes shoreline for the Michigan Department of Natural Resources. The atlas documents land use and development patterns along the shoreline of each county and includes topographic maps and other data. It will be an important tool for local units of government that must manage these vital coastal areas for commercial and recreational use while still maintaining their environmental integrity.

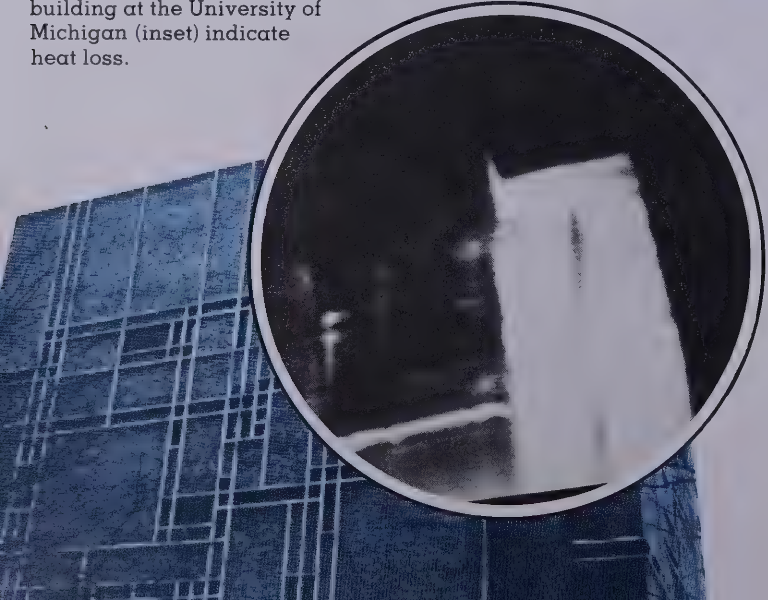
ERIM personnel used multispectral scanner technologies to map shoreline intertidal communities along the Alaskan coast for the National Oceanic and Atmospheric Agency, to help the agency decide which portions of the coast should be protected against possible oil spills.

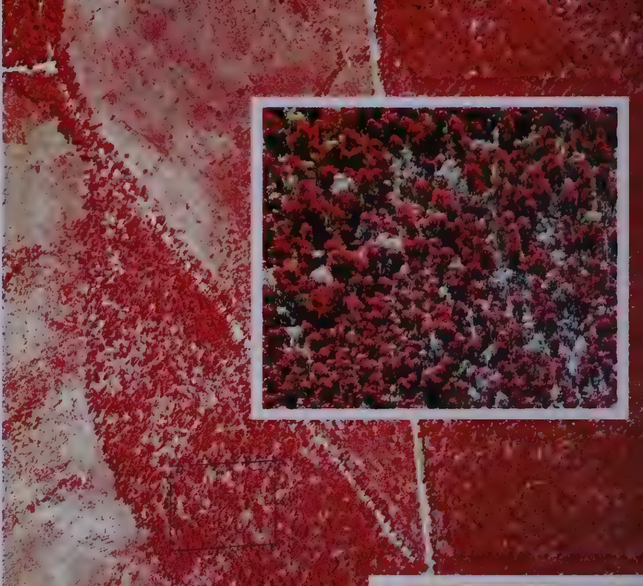
MIDAS (Multivariate Interactive Digital Analysis System) is a special, high-speed computer system designed and built at ERIM to digitally process, analyze, and display multispectral scanner data. It is equipped with the following: a DEC-PDP-11/45; an input subsystem; a feature extractor/ preprocessor; a control subsystem; a digital classifier; and a user-interactive display system, including color CRT and/or inkjet printer outputs.

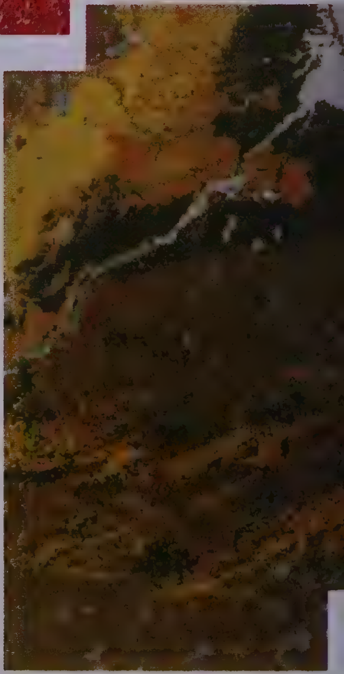


During their data collection flight along the Alaskan coast, researchers were able to inventory whale feeding grounds and sea lion rookeries like the one shown here, on the "Needle," west of Montague Island in the Gulf of Alaska.

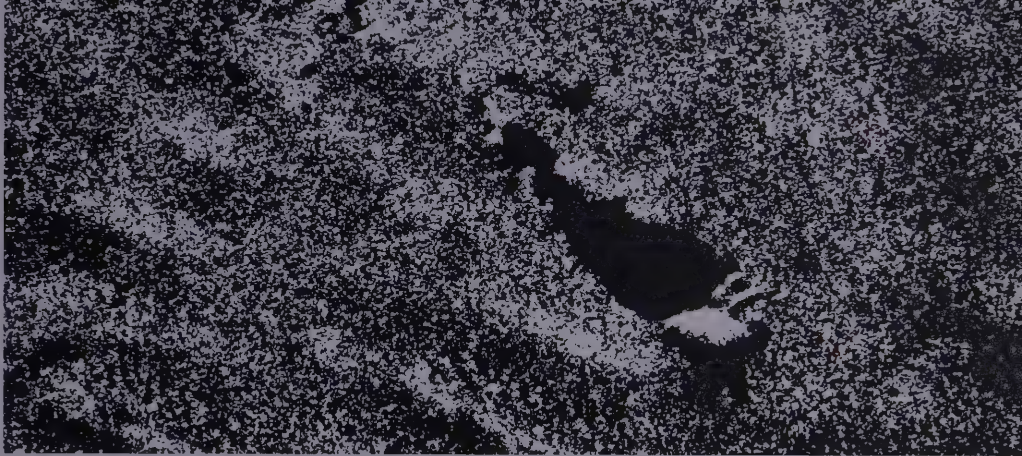
Some of the light areas on the thermal-infrared imagery of a building at the University of Michigan (inset) indicate heat loss.





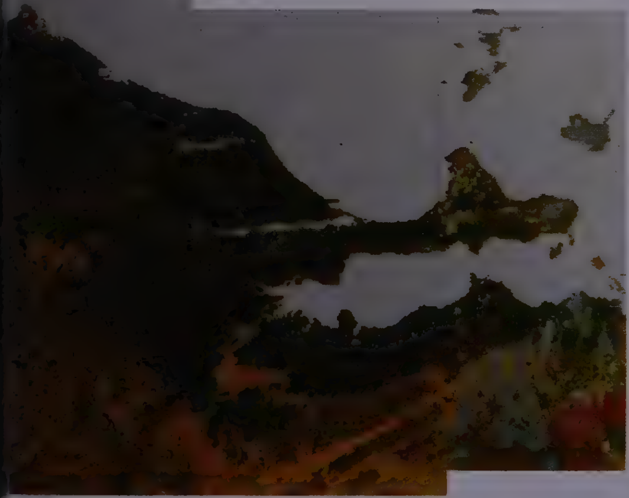


These aerial photographs of the Sam Houston National Forest in Texas illustrate the complex arrangements of components within a typical forest stand.

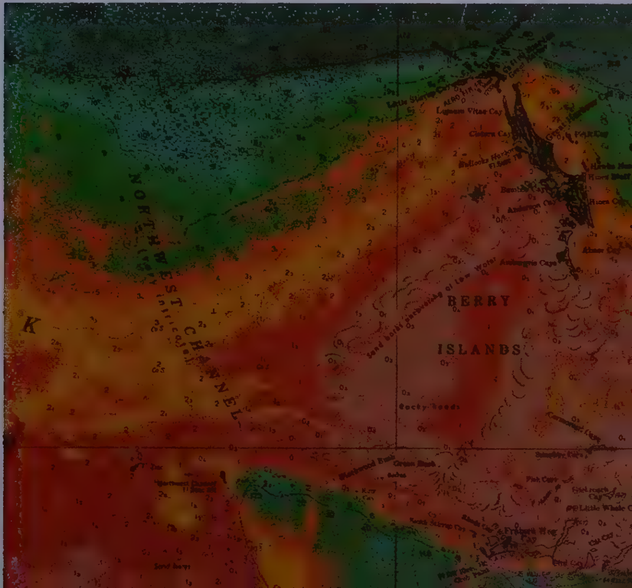


X-band radar image of an iceberg drifting through pack ice off the Labrador coast—dark sections are newly frozen areas and ridged pattern indicates wave movement under the ice.

Land use map of the Toledo metropolitan area, obtained by interpreting color-infrared aerial photographs and processing the data with ERIM's MIDAS computer.



Bathymetry map of a portion of Great Bahama Bank derived from Landsat-1 data and onsite measurements.



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COHERENT OPTICS and HOLOGRAPHY

INFORMATION DISSEMINATION

One of the most important problems in modern society is that the holders of scientific and technical information are often not able to communicate it to those who could benefit by its use.

Recognizing this problem, we at ERIM have made the dissemination of information about scientific and technological advances (at all levels, from local to international communities) one of our most important functions.

The ERIM Information Center was established to provide reference and research information and materials in support of research tasks. The EIC conducts on-line searching of data bases, and serves as a link with outside information centers. The facility houses some 70,000 hard copy or microfiche reports and 10,000 monographs, subscribes to 170 journals, and collects all ERIM publications. It also produces a yearly bibliography of ERIM publications, and assists with bibliographic searching required for research tasks.

ERIM's Publications Department exists to help researchers meet contractual requirements and maintain professional standards in the generation and production of technical reports and related materials. Hundreds of these reports, which document all aspects of ERIM's research and development projects, are released each year with assistance from one or more of the Publications units—writing/editing, art, photography, and printing.

DEVELOPING NATIONS

For several years, ERIM has been working with the Agency for International Development (AID) to help the United States contribute to economic and social development in the less developed countries of the world.

Most of ERIM's work has been concerned with administering AID grants and training programs in selected countries in Africa, Asia, and South America. The aim is the introduction and application of remote sensing technology—especially the use of satellite data—to collect vital information that would help improve the standard of living. ERIM experts travel all over the world to provide technical assistance to local scientists. In addition, ERIM helps technically define and support other AID programs.

With sponsorship from the United Nations Development Program and the Food and Agriculture Organization, ERIM conducted an on-the-job training program for four scientists from Bangladesh. Under this program ERIM is also responsible for processing Landsat data to obtain agricultural crop statistics and to map land accretion in the Bay of Bengal.

This Intelsat station in Zaire is an example of equipment that will help developing countries move rapidly into the modern technological age.

IRIA

The Infrared Information and Analysis (IRIA) Center is one of eight Department of Defense Information Analysis Centers, administratively managed and funded by the Defense Supply Agency and supported by all three military services.

IRIA's basic task is to collect, analyze, and disseminate information on the vast amount of research and development taking place in infrared, electro-optics, and laser technologies.

In addition to assisting many visitors from government and industry each year, the center publishes the "Infrared Newsletter," handbooks, bibliographies, and other reports. It also administers and publishes the proceedings of the National Infrared Information Symposium (IRIS) and the five IRIS specialty group symposia each year, as well as Department of Defense Laser Conferences in alternate years.

RADAR SYMPOSIA

Another major conference, the Tri-Service Radar Symposium, is administered each year by ERIM personnel from the Radar and Optics Division. As its name implies, the symposium is sponsored by all three services who, since the twelfth meeting in 1966, have taken it in turn to host the program—at the U.S. Military Academy in West Point, New York, the U.S. Air Force Academy in Colorado Springs, Colorado, or the Naval Postgraduate School in Monterey, California.

The purpose of the Tri-Sevice Radar Symposium is to give researchers an opportunity to discuss significant developments and technological advances in radar techniques, devices, and applications, as well as in related electronics fields.

IRIA's technical staff offers specialized research services for subscribers.

Periodically the U.S. Military Academy at West Point, New York hosts the Annual Tri-Service Radar Symposium.

REMOTE SENSING CENTER

ERIM's Center for Remote Sensing Information and Analysis acts as an international clearinghouse for all types of information, consultation, and training in this broad interdisciplinary field.

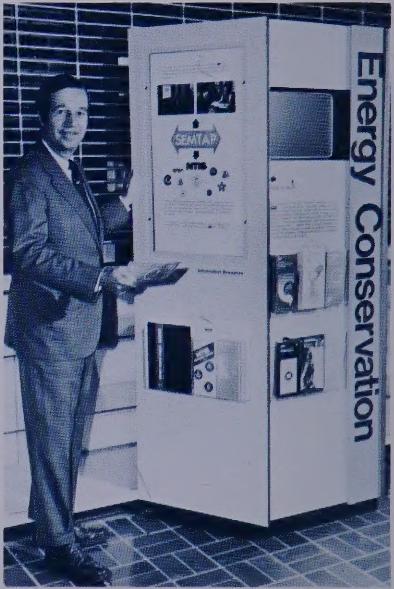
The International Symposium on Remote Sensing of Environment gives scientists an opportunity to discuss the most recent developments in the use of remote sensing technology for properly managing the earth's resources. It is now staged annually, at various sites throughout the world such as Manila, Philippines where the symposium highlighted the application of remote sensing by developing countries.

SEMTAP

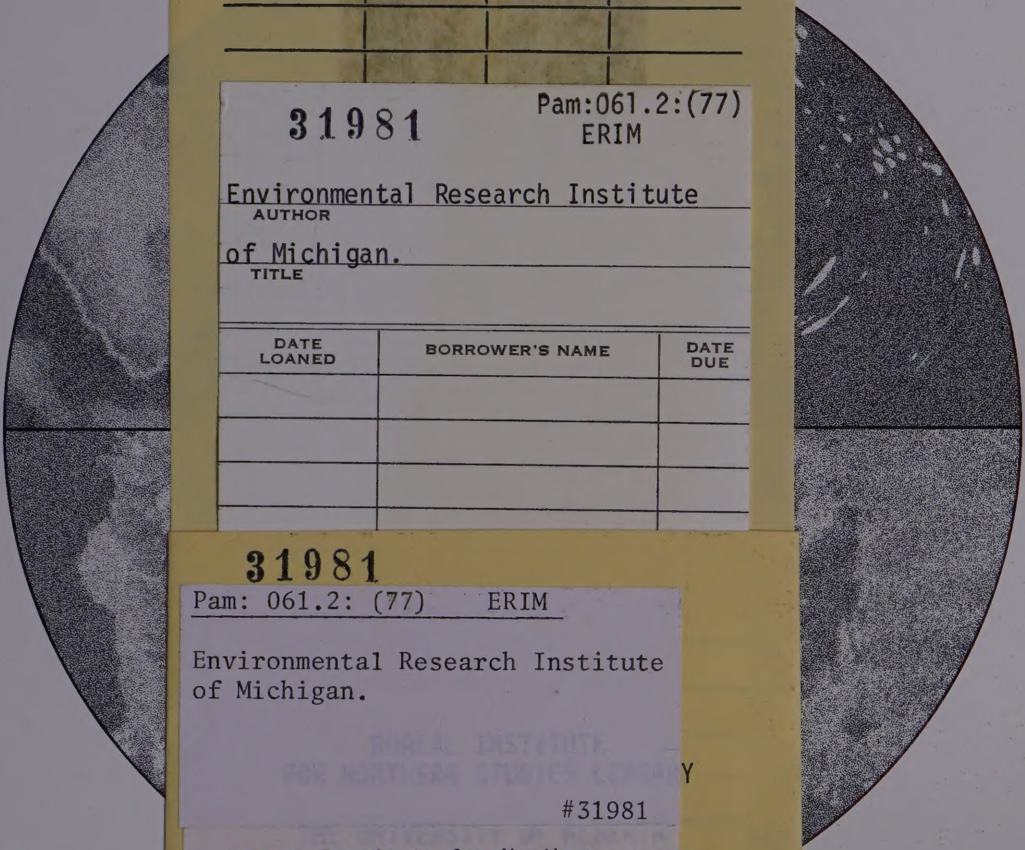
ERIM recently joined with ten area community colleges to develop a unique system for technology transfer. SEMTAP (Southeastern Michigan Technical Assistance Program) is intended to provide an improved method for transferring information to users in the community about techniques, procedures, and products that have been developed with federal research and development funds.

SEMTAP activities include conferences, meetings, special courses, and new information services on topics of special interest. The initial emphasis of the program is on energy conservation, aimed toward small or medium-size businesses.

Jacques Cousteau addressing the Tenth International Symposium on Remote Sensing of Environment.



Portable display units are used to promote SEMTAP in the community at large.



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